

DEPARTMENT OF WATER RESOURCES

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March 29, 2019

The Honorable Jim Nielsen, Senator, 4th District
State Capitol, Room 2068
Sacramento, California 95814

The Honorable James Gallagher, Assembly Member, 3rd District
State Capitol, Room 2518
Sacramento, California 95814

Thank you for your February 20, 2019 letter containing your comments and questions following the January 10, 2019 meeting of the Oroville Dam Safety Comprehensive Needs Assessment Project (CNA) Ad-Hoc Committee. Again, we appreciate the spirit of collaboration that you have brought to this important effort.

First, I would like to address your statement about feeling like you have not received an adequate response to your August 2018 Comment 2 regarding a proposed criteria to evaluate safety and reliability. The process for assessing risks to safety and reliability is an ongoing effort, has been discussed at each of our Independent Review Board (IRB) and Ad Hoc Group meetings, and is on the agenda for our next meeting as well. However, as the IRB stated in their response to your Comment 2, "the notion that there is a discrete threshold between safe and unsafe conditions is not an appropriate model for assessment of safety issues." Arriving at a common understanding of how to view risks to safety and reliability is an outcome that I hope we will be able to achieve through our continued discussion on this topic.

Since the receipt of your February letter, Assemblymember Gallagher and I met to further discuss participation of Ad Hoc members in the risk assessment workshops. Because those proceedings focus on information that the Department of Water Resources (DWR) must maintain confidential for national security purposes, the risk assessment proceedings cannot be opened to members of the public, including members of the Ad Hoc group. However, as independent technical experts, members of the IRB have observed the risk assessment workshops and are available to summarize the proceedings for the Ad Hoc group.

Below are the responses to your most recent comments numbered four and five. Additionally, attached is a full response to each of the five questions provided with your letter.

Ad Hoc Group Comment No. 4

Provide the proposed metrics that will be used to 'determine' the existing level of reliability and resilience as well as modifications to the existing level of reliability and resilience through the proposed 'enhancements.'

Response to Comment No. 4

As background to this response please see the definitions of terms below that are taken from the draft CNA Glossary. The CNA will consider **reliability**, **resiliency**, and **redundancy** during the formulation and evaluation of potential **measures** and alternative **plans** that will be recommended for consideration in enhancing dam safety and operational reliability of the Oroville Dam project facilities.

Reliability	(1) The probability that the system under consideration is in a non-failure state (Hashimoto, T., et al., 1982). (2) The likelihood of successful performance. Mathematically, reliability = 1 – P of unsatisfactory operation (USACE 2014, second definition added per IRB request).
Resiliency	The ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or manmade, under all circumstances of use (USACE 2014, definition added per IRB request).
Redundancy	Duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or fail-safe (USACE 2014, definition added per IRB request).
Risk	A measure of the probability and consequence of uncertain future events. It is often reduced to the simple equation: $Risk = Consequence \times Probability$ (USACE Institute for Water Resources (IWR) 2017-R-03 Planning Manual Part II: Risk Informed Planning)

Risk assessment	In the case of dams: The process of considering the results from a quantitative or qualitative estimated risk analysis of an existing dam or project, along with other factors related to a safety decision. These factors can include the dam safety case, social/economic impacts, environmental impacts, constructability, and potential to do harm. The risk assessment is conducted to determine a recommended course of action (which may involve considering a range of options) for mitigating or accepting the risks related to a specific dam or project or with regard to a specific dam safety issue or operational concern on that project (FERC Risk Informed Decision Making, Ch. 3, citing FEMA 2015).
Measure	An elemental building block of an alternative plan; a feature or activity that can be implemented at a specific location and point in time to address one or more planning objectives (USACE IWR 2017-R-03).
Alternative plan	A set of one or more measures functioning together to address one or more planning objectives. Alternative plans should be significantly differentiated from one another (USACE IWR 96-R-21).

The approach for developing alternative plans that will enhance the safety and reliability of existing facilities is to use a planning study process that begins with identifying project needs, objectives and constraints. The next step in the process is to evaluate the adequacy of existing facilities using a "no project" risk assessment (Existing Conditions Assessment). Project measures and alternative plans will then be developed using the identified needs, objectives, constraints and design considerations to enhance the overall project through risk reduction.

Project measures and alternative plans will be evaluated using established criteria from DWR's Asset Management Risk Matrix. In summary, the principal metric for evaluating potential project enhancements is risk reduction, as achieved through the implementation of selected proposed project alternatives (plans). This use of the DWR Asset Management Risk Matrix is covered in more detail in DWR's response to the Ad Hoc Committees Question 1, attached.

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Ad Hoc Group Comment 5

Confirm that USACE has been appropriately engaged in Task 2 "Operations Needs Assessment to Support Development of Alternative Reservoir Outflow Enhancements" as this task directly relates to flood control operations, which are regulated per the 1970 Operations Manual, and established through the cost-share agreement between USACE and State of California on March 8, 1962.

Response to Comment 5

DWR has been closely coordinating with the United States Army Corps of Engineers (USACE) water management staff in the development of the Interim Operations Plans during the emergency recovery of the Lake Oroville spillways as evidenced in the attached January 3, 2019 letter from Colonel Ray to Deputy Director Joel Ledesma. During the course of those coordination meetings we have kept USACE apprised of the scope and status of the CNA process, including Task 2. We have a common understanding with USACE that the Task 2, "Operations Needs Assessment to Support Development of Alternative Reservoir Outflow Enhancements," will serve as foundational information for an eventual update to the Water Control Manual. DWR will continue our engagement with USACE as the CNA process progresses.

Again, we thank you for your efforts to increase the understanding of these important issues with your constituents and look forward to our fourth meeting of the Ad Hoc group on April 5, 2019.

Sincerely,



Joel Ledesma
Deputy Director
State Water Project

Attachments

Responses to Ad Hoc Committee Questions
Submitted February 20, 2019 following Third Ad Hoc Committee Meeting

Responses provided by Department of Water Resources, March 29 2019

This document provides responses to questions submitted by the Ad Hoc group on February 20, 2019 following the third meeting with DWR in January 2019.

Question 1

With source of funding established, please explain the risk assessment criteria for establishing priorities and timelines for recommendations coming out of both the Level 2/Part 12D, and the CNA process. Does the framework weigh public safety, water deliveries, etc.?

Response:

The Federal Energy Regulatory Commission's (FERC) Part 12D/Level 2 risk analysis and the CNA Initiative are two separate processes that fulfill different purposes:

- The Part 12D process includes an inspection and report by an Independent Consultant that must be completed and filed every five years with FERC, a federal requirement for high hazard dams including Oroville. The current Part 12D effort is the tenth such 5-year review for Oroville Dam.
- DWR initiated the Oroville Dam Safety Comprehensive Needs Assessment (CNA) Project in May 2017 as an initiative to identify and prioritize potential enhancements to improve both dam safety and operational reliability.

As a result, the Part 12D inspection and the CNA will produce different deliverables such as reports or identified potential reduction measures, and on different timelines. However, DWR has worked to align the two efforts so each will inform and benefit the other.

Part 12D Inspection and Level 2 Risk Analysis

The Oroville Dam Part 12D process fulfills the requirements of Title 18, Part 12, Subpart D of the Code of Federal Regulations for high hazard dams, which requires an inspection and report by an Independent Consultant that must be completed and filed every five years with FERC. The Department of Water Resources (DWR) is well-versed in the FERC Part 12D process as it has gone through numerous 5-year Part 12D reviews for several of its dams in both the Oroville-Thermalito Complex and in southern California. The current Part 12D effort is DWR's tenth such 5-year review for Oroville Dam. With FERC's review and approval, DWR has retained two prominent, internationally recognized Engineering Consultants and a California Certified Engineering Geologist to serve as the 10th Part 12D Independent Consultant. Their independent inspection, review, and analysis of project documentation will culminate in the 10th Part 12D report for Oroville Dam. This process and report also fulfills the requirement for an independent safety review pursuant to Title 23 (Division 2, Sections 330-333) of the California Code of

Regulations and to Section 6056 of the California Water Code that requires DWR to retain an independent Director's Safety Review Board on a five-year cycle to review DWR owned dams.

The Part 12D process typically requires that a licensee review and update the Potential Failure Mode Analysis (PFMA) for the subject dam. In the case of Oroville Dam, DWR had previously planned to conduct a full PFMA workshop as was conducted in 2014 for the Ninth Part 12D process, rather than a minimal review and update of the previous risk analysis. In September 2018, federal legislation was passed directing FERC to require the licensee of Oroville, DWR, to request the United States Society on Dams (USSD) to nominate independent consultants to perform a Level 2 risk analysis, consistent with FERC's guidelines, for use in conducting the Part 12D safety review of Oroville Dam (note that this is a separate independent panel than the 10th Part 12D FERC-approved Independent Consultant).

The Level 2 risk analysis is a semi-quantitative risk evaluation that consists of the normal, full PFMA effort plus the consideration of risk (likelihood and consequence) for each potential failure mode (PFM) that is identified, developed, and evaluated. After the development of each PFM is completed and its risk estimated, potential risk reduction measures are identified for that PFM for DWR to consider.

The Level 2 Risk Analysis Team is responsible for facilitating and authoring the Level 2 risk analysis report(s). The 10th Part 12D Independent Consultant is attending the Level 2 risk analysis workshops but is not directly participating in the assessments of risk in the Level 2 risk analysis – that is the work to be done by the separate independent panel. However, the Independent Consultant will consider the results and findings of the Level 2 risk analysis in the development of their recommendations in the Part 12D Report. The Level 2 risk analysis will also help serve as a baseline of risk (i.e., existing condition) for the Oroville facilities in the CNA efforts.

Following the completion of the Level 2 risk analyses and its inspection and review of the facilities, the 10th Part 12D Independent Consultant will issue its 5-year report, expected towards the end of 2019. The report by the Independent Consultant will describe the facilities, summarize design assumptions and analyses, geologic conditions, inspection results and functionality, include an analysis of the safety of the facilities and the adequacy of the performance monitoring instrumentation and program. It will also summarize the results of the PFMA workshops and the Level 2 risk analysis. The report by the Independent Consultant will make recommendations for any corrective actions related to the facilities, their maintenance, methods of operation, performance monitoring, or new investigations or studies. The Independent Consultant also will outline a reasonable time to carry out each corrective measure, modification, or investigation.

DWR will submit the Part 12D report by the Independent Consultant to both FERC and the California Division of Safety of Dams (DSOD). FERC requires that licensees submit a plan and schedule to address the recommendations within 60 days. The plan of action may include any proposal, including taking no action, that a licensee considers appropriate to address actions recommended by the Independent Consultants in the Part 12D report. Any proposed alternative

action to address a recommendation must be supported by complete justification and detailed analysis and evaluation in support of that alternative action.

It is important to note that the Part 12D process is just one element of the State Water Project (SWP) Dam Safety Program. Independent Consultants commonly recommend start dates or completion dates for recommendations they consider high priority. DWR considers the Independent Consultants' recommended dates in the development of the plan and schedule that is submitted to FERC for approval. DWR also independently prioritizes recommendations through the annual SWP strategic planning effort which evaluates projects (in this case "recommendations") with the O&M Asset Management Risk Matrix for all of the facilities in the SWP portfolio. Public safety is weighted higher than all other SWP purposes. The process for implementing recommendations that will be made by the 10th Part 12D Independent Consultant are expected to remain essentially the same as in past years for Oroville and other DWR dams regulated by FERC.

Oroville Dam Safety Comprehensive Needs Assessment

DWR initiated the Oroville Dam Safety Comprehensive Needs Assessment (CNA) Project in May 2017 as an initiative to identify and prioritize potential enhancements to improve both dam safety and operational reliability. The commitment to complete this project was formalized in June 27 and June 28, 2017 letters to both FERC and DSOD. As outlined in these letters, the focus of the CNA Project is on enhanced dam safety and operational flexibility, but secondary benefits such as operational redundancy, improved compliance with downstream flow and temperature criteria, or possible power generation opportunities might also be realized by the implementation of recommended enhancements.

The CNA Project and the development of potential plans to be considered for improving dam safety and operational reliability is organized around six major tasks focusing on the major facilities and structural components of Oroville Dam. The *Needs* statements for these six tasks are now expressed as follows:

- Task 1 – What enhancements or new facilities for the Oroville Dam Spillways are needed to improve safety and reliability?
- Task 2 – What enhancements to Oroville Reservoir Operations are needed to improve safety and reliability?
- Task 3 – What enhancements or new facilities to the FCO Headworks Structure are needed to improve safety and reliability?
- Task 4 – What enhancements or new facilities for the Oroville Dam Outlet Works are needed to improve safety and reliability?
- Task 5 – What enhancements to Oroville Dam Embankments are needed to improve safety and reliability?
- Task 6 – What enhancements or new facilities to Oroville Dam Instrumentation and Monitoring are needed to improve safety and reliability?

These tasks consider potential enhancements or new facilities for all of the facilities at Oroville, including all three embankment dams (main dam and two saddle dams), both spillways (Emergency and FCO), all three outlets (Hyatt Power Plant, Palermo Tunnel, and the River Valve Outlet System), consideration of a new low level outlet, potential changes in operations, and enhancements or additions to the existing performance instrumentation and monitoring programs.

The first step in the CNA process is to assess the existing conditions and risks associated with these facilities. To the extent feasible, DWR will utilize the results of the ongoing Part 12D inspection process and Level 2 risk analysis and other assessment processes. DWR plans to evaluate the existing conditions of these facilities using an extended version of DWR's current Asset Management Risk Matrix framework. The DWR Asset Management framework involves a semi-quantitative risk evaluation that considers various PFMs and evaluates the likelihood (probability) of the event happening and its potential consequences. The potential consequences (consequence categories) that will be used in the CNA evaluation process were taken from DWR's Asset Management Matrix, previously presented to the Independent Review Board during Meeting No. 3 in December 2018.

The five consequence categories to be used in the CNA risk evaluation are:

1. Public Safety
2. Regulatory Compliance
3. Flexibility and Reliability for Water Delivery
4. Flexibility and Reliability for Other State Water Project Purposes (including flood control, power generation, recreation, and fish and wildlife preservation)
5. Financial Impacts (including potential damage to DWR facilities, other property damage, and loss of revenue)

The degree of acceptability for each of the five consequence categories for both existing and future conditions follows the well-established concept of *tolerable risk*. Tolerable risk levels are based on risk (likelihood and consequence) criteria established by the DWR Asset Management Risk Matrix. The tolerable risk levels in the Asset Management Risk Matrix for the Public Safety consequence category are comparable to those used by federal agencies such as the United States Army Corps of Engineers, United States Bureau of Reclamation, and FERC. The tolerable risk levels for the other four consequence categories were developed specifically for DWR's State Water Project.

Following the completion of the semi-quantitative evaluation of PFMs and the existing conditions assessment, the risks associated with the existing conditions will be assessed for their tolerability, and potential risk reduction *Measures* will be developed and considered for each facility (e.g., embankment, spillway, or outlet). The risk reduction measure could be a structural

improvement, a new facility such as a new low level outlet, a change in operations, or the addition of new performance monitoring instrumentation. Different combinations of measures will then be identified as alternative **Plans** for consideration. Both the individual measures and the plans (combinations of measures) will be evaluated for their risk reduction benefits using the Asset Management Risk Matrix and the five consequence categories described above. In the first round of evaluations, the costs to implement any particular measure or plan is not considered. In a second round, those measures or plans that have the most potential for risk reduction are evaluated for cost with the idea being that the plans that are most cost efficient (biggest risk reduction per dollar) are rated higher. At the end of the CNA project, the risk reduction plans providing the highest risk reduction for the cost will be recommended to DWR management for future consideration.

The actual timeline for implementation of the risk reduction plans will depend upon the risks identified in the existing conditions assessment, their tolerability, and similar such risks for other facilities in the DWR SWP portfolio. As do other civil works agencies with large portfolios, DWR will weigh the current risks at Oroville against risks at other facilities in the SWP, including other major dams such as B. F. Sisk, Castaic, Pyramid, Cedar Springs, Perris, Del Valle, or Bethany Dams and major pumping plants, power plants, siphons, and aqueducts. The facilities that have the highest risk will have risk reduction measures applied first. It is for this reason that the DWR Asset Management Matrix was chosen, so the same criteria and evaluation process is applied across the board to all SWP facilities.

At the same time, there are certain risk reduction measures that will likely be identified in the CNA process for early implementation by DWR. These would be measures that are identified as effective risk reduction measures that should be done regardless of the eventual plan selected for implementation. Three such measures have already been identified for Oroville Dam and are scheduled to begin implementation later this year:

1. The installation of 11 new piezometers in the galleries beneath the central clayey core and in the embankment and abutments near the downstream toe.
2. The installation of several new piezometers underneath the FCO Headworks Structure.
3. A new seismic stability evaluation of the main dam using recently developed updates of seismic loadings and state-of-the-art analysis methods.

Question 2

In the 2014 Part 12D Probable Failure Mode (PFM) Analysis report, 12 of the 13 PFM candidates under Operations were redacted under CEII. DWR has considered hiring an independent consultant to help communicate CEII information so as to engage the Ad Hoc Group in these important matters.

- *What is the status of improving the communication in these areas?*
- *Are there limits in the current Water Control Manual (WCM) that are a candidate for a Probable Failure Mode?*

Response:

DWR is committed to enhancing the community's understanding of the Oroville Dam, its facilities and their associated risks and benefits. Simultaneously, DWR must ensure the safety of each facility as well as downstream communities by restricting information that could be used for destructive purposes. This includes protecting specific details, such as the Potential Failure Modes mentioned in your question. The protection of certain Critical Energy Infrastructure Information (CEII) is a requirement¹ of the Federal Energy Regulatory Commission. Information of this type is shared with local law enforcement as well as the Independent Review Board. DWR expects to share high-level summaries of the Potential Failure Mode Analysis effort with the public through the Ad Hoc Group over the next several meetings.

The Water Control Manual for the operation of Oroville Dam facilities and Lake Oroville is a guide and set of rules for the operation of the reservoir during normal operations and flood events. The rules are oriented to provide dam safety and flood risk management in accordance with federal authorizations to provide flood space reservations within the reservoir during different periods of the year. As such, the rules set forth in the Water Control Manual themselves are not candidates for Potential Failure Modes (PFMs). However, there are several hydrologic PFMs that have been considered in the past and even more currently in the ongoing Part 12D PFMA workshops and Level 2 risk analyses. The development and evaluation of these hydrologic PFMs consider hydrologic and hydraulic routings of flood events that assume the rules set forth in the Water Control Manual are being followed. Thus, any potential limitations in the Water Control Manual are being incorporated in the ongoing PFM evaluations.

Question 3

The upcoming Level 2/Part 12 D will be a very extensive process with the largest and most qualified team ever assembled for the Oroville Facility. In preparation numerous seismic and geology analysis/studies have been completed to help in the evaluation of both Static Loading and Earthquake-Loading PFM Candidates. DWR contributed data and was a co-funder in the development of Atlas 14 which became effective in California 2011. Why wasn't a new PMF study performed ahead of the Level 2/Part 12D and CNA process to be compliant with new standards and for evaluation of Flood Loading and Operation PFM Candidates.

Response:

DWR initiated a new Probable Maximum Flood (PMF) study in 2016 to address a recommendation made by a previous Part 12D Independent Consultant. This study (by David Ford Consulting Engineers for DWR). complies with all current FERC standards, uses state of art models and modeling methods, and considers updated information related to precipitation depth-duration-frequency estimates and improved snow accumulation monitoring and modeling methods. Sensitivity analyses show that the results of the new PMF study to be completely

¹ <https://www.ferc.gov/legal/ceii-foia/ceii/guidance-dam.pdf?csrt=10858039665272243829>

consistent with those obtained using NOAA Atlas 14. In-progress reviews were completed by FERC staff.

The calculation methods and results for the new PMF study were presented to the Oroville Spillway Recovery Independent Board of Consultants (Spillway BOC). The Spillway BOC reviewed the updated PMF and commented as follows in its October 2017 meeting:

"The BOC believes the PMF update study is thorough and the level of detail is appropriate for a dam of such significance. The BOC is in agreement with the approach used to update the PMF and believes the findings of the study are reasonable and conservative. The BOC commends DWR's consultant for their effort and the quality of the analyses."

The updated PMF results and details of computation were submitted to FERC on September 29, 2017 for their review. The review of this PMF study by FERC staff was detailed in their October 25, 2018 letter to DWR that appears to be the subject of Question 4 by the Ad Hoc Committee (see below). Additional sensitivity analyses will be submitted to FERC to address questions raised by FERC in their recent review. The results of this updated PMF study are considered to be CEII information, but are being made available to the Level 2 risk analysis participants.

Question 4:

There seems to be some confusion regarding the restored capacity of the combined Main Flood Control Outlet (FCO and the Emergency Spillway. A letter from FERC stated the combined output of both the FCO and Emergency Spillway is 400,000 cfs that appears to be much lower than prior estimates of the capacity needed to pass the Probable Maximum Flood (PMF). Can you please elaborate on this discrepancy?

Also is a new PMF being created? If so, please explain the process and who will be involved in constructing a new PMF?

Response:

It appears that the FERC letter that is being referred to in this question may be the October 25, 2018 letter from FERC to DWR providing review comments on the new updated PMF analyses completed for DWR by David Ford Consulting Engineers and submitted by DWR to FERC on September 29, 2017.

FERC notes in its October 25, 2018 letter that the peak outflow on the Emergency Spillway, by itself, during the PMF is approximately 420,000 cfs (see Page 2 of the FERC letter). The question being raised by FERC staff is not whether the Emergency Spillway would pass its share of the PMF (it would), but rather how much erosion and damage to the recently installed Secant Pile Wall, roller compacted concrete (RCC) apron, and existing ogee monoliths would occur at different discharges on the Emergency Spillway. The Emergency Spillway is currently designed

to pass 100,000 cfs without significant damage to the recently added armoring due to scour erosion. During large flood events, the gated FCO Spillway would be flowing another approximately 300,000 cfs. Thus, the combined flows of both spillways would be expected to be approximately 400,000 cfs without any significant damage expected to either spillway. Discharge flows larger than 100,000 cfs on the Emergency Spillway might result in damage to the armoring, but this would not reduce the ultimate capacity of the Emergency Spillway to discharge its share of the PMF. This is because the flow capacity on the Emergency Spillway would not be significantly impaired by any potential scour or erosion damage to its armoring. During the PMF, approximately 420,000 cfs would be flowing down the Emergency Spillway and another flow of about 300,000 cfs would be flowing down the gated FCO Spillway, for a combined peak outflow of approximately 720,000 cfs for both spillways. As noted in the FERC letter, the still water level of the reservoir during the peak of the updated PMF would still be at least 2.9 feet below the top of the main embankment dam, although waves might conceivably break over the top of the embankment crests during the limited time of the peak.

The CNA is considering the potential scour erosion damage to these facilities and potential enhancements or new facilities to address scour erosion damage as part of Task 1: *What enhancements or new facilities for the Oroville Dam Spillways are needed to improve safety and reliability?*

And, as stated above, a new PMF analysis following current procedures was completed and submitted to FERC on September 29, 2017.

Question 5

Downstream communities are concerned about the Department of Water Resources (DWR) current ability to forecast inflows into Lake Oroville during the winter season. There are many variables within the hydrology equations used to determine risks. These include:

- a) Wetness Index*
- b) SPF rain on snow melt inflow increases.*
- c) Accuracy of upstream reservoir storage credits*
- d) Accuracy of predicting inflows from upstream river gages*

In your Level 2 analysis, are you going to review your current forecasting capabilities and equipment to ensure forecasted inflows are more accurate? How can you be more transparent with the public on reservoir flood capacity and forecasted inflows?

Response:

Forecasting inflows to Lake Oroville during the winter season is accomplished jointly by DWR, and the California Nevada River Forecast Center (CNRFC) of the National Weather Service. These agencies use state-of-the-art models of watershed hydrology and stream hydraulics—models that capture variables listed above and more. The watershed and channel models are driven by observations from the extensive network of rain, snow, temperature, and stream gages

in the contributing watershed and state-of-the-science forecasts of future precipitation and temperature. Review of the current forecasting capabilities and equipment is an on-going activity of DWR and its partner agencies at the Joint Operation Center (JOC) in Sacramento.

Even if inflow forecasts precisely captured the physical watershed response of a given precipitation event the inflow forecasts can only be as good as the precipitation forecasts. It is widely understood that weather forecasts are never perfect and minor departures in temperature, wind, or moisture assumptions can result in very different direct runoff outcomes.

In a never-ending effort to improve weather forecasts, significant investments have been made by DWR and other governmental agencies over the years to continue improving forecast tools and prediction capabilities. One recent example of these investments by DWR includes the recent installation of Atmospheric River Observatories. These weather stations are anticipated to improve forecasting capabilities of severe storm events by filling in important observation gaps with radar measuring wind profiles and snow levels during atmospheric river events in the Feather Basin. There have been significant investments and incremental improvements in weather and inflow forecasting over the past fifty plus years since construction of the dam.

Although these continuing improvements in forecasting capability represent significant enhancements to flood operations of the dam, effective flood operations of Lake Oroville are not dependent on accurate inflow forecasts. The design of the dam's outflow capabilities and flood operations rules are effective to safely route extreme storm events downstream based entirely on observed inflow alone.

Consideration of the Standard Project Flood (SPF) is not a component of real-time forecasting, as suggested in this question. The SPF is a design flood developed, as described in the Ad Hoc Committee meeting of January 10, 2019, for derivation of flood operation rules included in the U.S. Army Corps of Engineer's water control manual and for balancing the need for spillway capacity and storage. The SPF is sufficiently large to ensure that the facility can manage all but a tiny fraction of flood events conceivable for the Feather River watershed. Forecasters and operators do not presume every flood will have properties similar to the SPF. Operators use results of the forecasted and observed inflows in combination with detailed models of the reservoir operation to make flood release decisions to control and mitigate risk.

In the ongoing Level 2 risk analysis, hydrologic Probable Failure Modes (PFMs) will be considered and evaluated based on the existing abilities for the National Weather Service, and DWR to forecast inflows on the Feather River into Lake Oroville, and for predicting rises in the reservoir and downstream river stages. The Independent Panel convened to perform the Level 2 risk analyses, and perhaps the CNA teams, may identify potential risk reduction measures that may include forecasting tools or procedures if those would improve reservoir operations.

DWR makes considerable efforts to be transparent and provide the public not only with information on current reservoir inflow and outflow conditions, but also forecasted rises in

reservoir levels and river stages. DWR, in partnership with the National Weather Service's California Nevada River Forecast Center, operates the California Data Exchange Center (CDEC) which is an online service that the public can easily access to obtain information on current conditions and projected future changes in reservoir and river levels. The CDEC is available online at <https://cdec.water.ca.gov/>

Examples of the information available on CDEC and the CNRFC websites are provided below. These show two March 6, 2019, screen shots. The first screen shot shows recent hourly reservoir operations at Lake Oroville, and the second one shows current and forecasted precipitation and changes in river stage on the Feather River near Gridley. In addition, the information presented for each river gage also presents the river stages corresponding to *Monitor*, *Flood*, and *Danger* stages, as well as the peak stages of record, so that members of the public can better understand what the current and forecasted conditions mean with respect to flood risk.

Throughout the winter and spring DWR publishes news releases and community notifications about lake levels and DWR operational trigger points as precipitation and snow melt create inflows to the reservoir. For example: <https://water.ca.gov/News/News-Releases/2019/March/Update-on-Oroville-Reservoir-Levels-and-Operations-March-1-2019>.

During flood conditions, DWR also operates the Flood Operations Center which disseminates information to the public, coordinates activities of various agencies, provides coordination and material support to local agencies for levee patrolling and flood fighting, and responds to inquiries from the public. During major floods, the Flood Operations Center conducts multiple briefings to the media and public each day reporting on projected river stages and reservoir operations. The National Weather Service CNRFC also provides their forecast of river and flood conditions, weather, and climate available to the public on their web page.

This screen snapshot of the publicly-accessible California Data Exchange Center (CDEC) website on March 6, 2019 shows near-real-time reservoir pool elevation, storage, and outflow from Oroville Dam as well as actual and scheduled releases to the Feather River downstream of Thermalito Afterbay outlet.



OROVILLE DAM (ORO)

Elevation: 900.0' · FEATHER R basin · Operator: CA Dept of Water Resources/O&M Oroville Field Division

Station comments:

02/23/2017 Outflow from Oroville includes all releases from the Oroville Dam (i.e., Hyatt, spillway, low flow outlet), while River Release (RIV REL) pertains to the Oroville Complex as a whole which includes any releases from the Diversion Dam gates and Thermalito Afterbay River Outlet.

Query executed Wednesday at 13:28:58

Provisional data, subject to change.

Select a sensor type for a plot of data.

HOURLY DATA

Earlier

DATE / TIME	RES ELEV	STORAGE	OUTFLOW	INFLOW	RIV REL	RAIN	BAT VOL
PST	FEET	AF	CFS	CFS	CFS	INCHES	VOLTS
03/06/2019 02:00	815.07	2,366,426	4,394	27,378	5,006	36.00	13.4
03/06/2019 03:00	815.23	2,368,330	4,353	27,368	4,967	36.01	13.4
03/06/2019 04:00	815.37	2,369,998	4,318	25,415	4,968	36.14	13.4
03/06/2019 05:00	815.54	2,372,024	4,299	27,549	4,980	36.14	13.4
03/06/2019 06:00	815.70	2,373,932	8,146	27,671	4,967	36.14	13.4
03/06/2019 07:00	815.84	2,375,603	5,536	28,868	4,968	36.19	13.4
03/06/2019 08:00	816.02	2,377,752	4,300	30,063	4,967	36.22	13.4
03/06/2019 09:00	816.20	2,379,902	4,018	29,555	4,967	36.24	13.4
03/06/2019 10:00	816.42	2,382,531	4,048	33,075	5,246	36.24	13.4
03/06/2019 11:00	816.60	2,384,664	4,018	32,874	6,017	36.24	13.4
03/06/2019 12:00	816.83	2,387,438	4,053	33,722	6,835	36.24	13.4
03/06/2019 13:00	817.03	2,389,834	4,038	34,402	7,040	36.25	13.4

Showing 1 to 12 of 12 entries

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Later | Latest

EVENT DATA

DATE / TIME	REL
PST	SCH
	CFS
03/06/2019 10:00	6,000
03/06/2019 12:00	7,000

Showing 1 to 2 of 2 entries

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[CSV](#)
[Print](#)
[PDF](#)

Earlier | Later | Latest

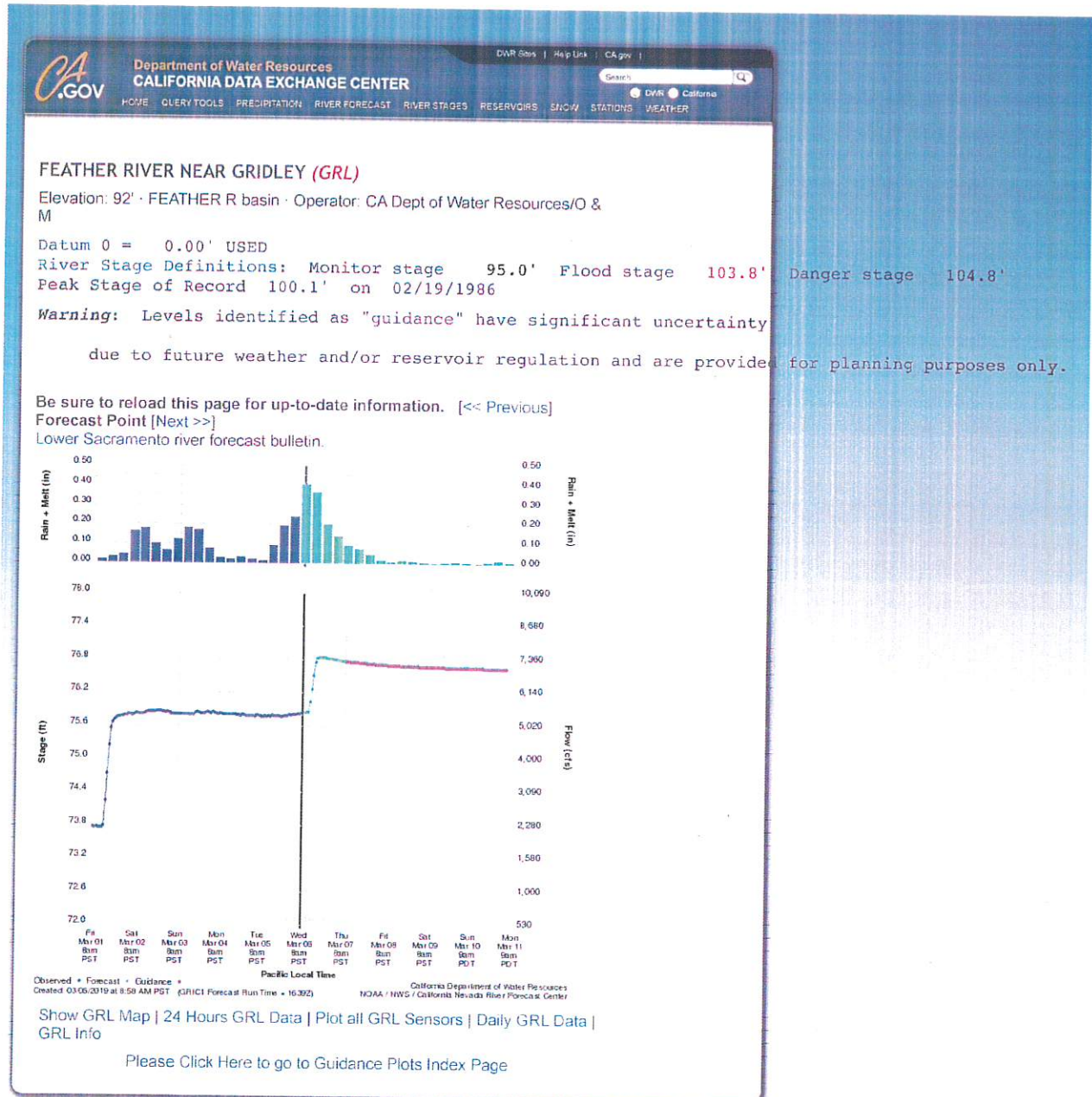
BRT and ART signify discharge at stage below or above available rating table

Warning! This data is preliminary and subject to revision.

[Show ORO Map](#) |
 [24 Hours ORO Data](#) |
 [Plot all ORO Sensors](#) |
 [Daily ORO Data](#) |
 [Monthly ORO Data](#) |
 [ORO Info](#)



This screen snapshot of the publicly-accessible California Data Exchange Center (CDEC) website on March 6, 2019 shows near-real-time flow and stage at Gridley, along with 5-day future forecasts. Similar graphs are available on the website for other locations.





DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Executive Office

JAN 03 2018

Mr. Joel Ledesma
State Water Project Deputy Director
1416 Ninth Street
P.O. Box 942836
Sacramento, CA 94236-0001

Dear Mr. Ledesma:

Thank you for your letter received November 26, 2018 in which you request concurrence on the Lake Oroville 2018-2019 Flood Operations Plan ("Plan"). The coordination between your staff and our Water Management Section has been very helpful in understanding the status of the recovery and construction efforts at Oroville Dam, the anticipated full operational capability of Oroville Dam, and the details of this request.

Our responsibility in the operations of Oroville Dam is to assure that its authorized flood control purpose is met per our 1970 Water Control Manual ("Manual") for Lake Oroville and supplemental agreements. Our review of your Plan was performed from this context, and has resulted in the following findings:

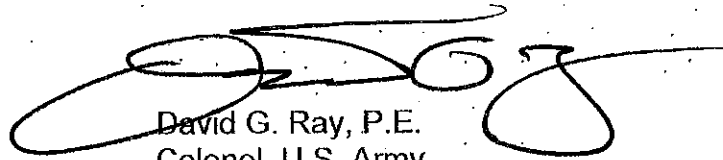
- a) The Plan's Interim Enhanced Flood Pool supplements the volume of flood storage required by our Manual.
- b) In the event that pool elevations encroach into authorized flood storage space, the Plan incorporates the operations prescribed by our Manual.
- c) The Plan lowers downstream flood risk relative to that provided by the Manual.
- d) The Plan includes contingency operations that are covered by our existing agreements.

The Plan does not deviate from our Manual or existing agreements. Therefore, relative to our regulatory role and associated policies, it does not require our approval or concurrence. Nonetheless, it is our view that your Plan, very responsibly addresses potential downstream flood risk effects.

We request that the findings of FERC and DSOD reviews of your Plan, and any anticipated revisions to your Plan be shared with us in a timely manner. We are committed to continuing our close coordination and support of sound flood operations at

Lake Oroville, through Mr. Joe Forbis, our Chief of Water Management, at 916-557-7828 or Joseph.C.Forbis@usace.army.mil.

Sincerely,

A handwritten signature in black ink, appearing to read 'D. G. Ray', with a large, stylized flourish extending from the end of the signature.

David G. Ray, P.E.
Colonel, U.S. Army
Commander and District Engineer